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A DEVICE FOR AND A METHOD OF MILKING AN ANIMAL, A DEVICE FOR MONITORING AN ANIMAL

The invention relates to a device for milking an animal, in particular a cow.

Such a device is known. Although these known devices function satisfactorily, there appear to be differences in milk yield and milk quality which cannot be attributed per se to the functioning of the device or the physical condition of the animals. Consequently, there is a need for an improved device for milking an animal.

It is an object of the invention to provide a device by means of which it is possible to satisfy this need at least partially.

For that purpose, according to the invention a device for milking an animal of the above-mentioned type is characterized by the measures mentioned in the characterizing part of claim 1. The invention is based on the insight that the milk yield and the milk quality are not only determined by the physical condition of health of an animal or the functioning of the milking device, but also by the degree of stress from which an animal suffers. By measuring, according to the invention, the stress of an animal before and during and preferably also after milking, there can at least be obtained a supplement to the conditions influencing the milk yield or the milk quality. These additional data may be used for making the milking device function more efficiently. In this situation by "milking" is meant milking during a milking run.

In this connection it is noticed that from WO 99 01026 it is known per se to monitor abnormal behaviour of an animal, e.g. by means of a movement meter, a respiration meter or a heartbeat meter. The milking can for example be interrupted when a certain abnormal behaviour gives reason therefor. However, measuring of the degree of

stress before and during milking is not known from this document.

Furthermore, from NL 1000883 it is known per se to use a smell sensor for breath or body odours for animal identification and/or health determination. However, measuring the degree of stress before and during milking is not known from this document.

Furthermore, from WO 00 13393 it is known per se to process animal sounds and to supply in dependence thereof a signal to a manager. However, measuring the degree of stress before and during milking is not known from this document.

Furthermore, from US 5 878 692 it is known per se to take an action in reaction to the measuring of animal sound, e.g. by opening a gate of a milking robot when the animal is in a panic. However, measuring the degree of stress before and during milking is not known from this document.

Furthermore, from SU 1 329 719 it is known per se to measure stress of animals by means of lymphocite fraction and by measuring the electrophoretic mobility. However, measuring the degree of stress before and during milking is not known from this document.

Furthermore, from EP 0 988 786 it is known per se to determine animal sounds owing to stress and, accordingly, automatically to bring about a reaction thereto. In this situation sounds issued by animals are analysed and possibly converted into control commands. Besides, images and/or movements may be analysed, if desired. However, measuring the degree of stress before and during milking is not known from this document.

In an embodiment of a device according to the invention the device is provided with means for determining milk related data and the storage device is adapted to store the stress measurement data together with the milk related data. In this manner there can be established a relation between the stress measurement data before, during and after

milking and the milk related parameters, such as milk yield, milk quality (fat content, protein content, etc.).

In particular the means for determining milk related data are suitable for determining the milk flow per udder quarter of an animal during milking.

In order to be able to process the data accurately per animal, the device is preferably provided with an animal identification system and with a central unit provided with a computer having a memory, said memory being adapted to contain per animal data in relation to the stress. Additionally or alternatively the data may also be processed per group or herd of animals.

It has appeared that for the determination of stress of an animal, per animal different parameters provide a stronger indication of the stress. Consequently it is important to store the stress related data per animal in the memory and, on determination of the degree of stress of an animal, to use in particular that stress measuring device or that combination of stress measuring devices that provides a clear indication for that animal. This in contrast with the known devices that are used without distinction for all animals. Therefore, the invention also relates to a device for determining the degree of stress of an animal, the device being provided with an animal identification system, various stress measuring devices, a memory for containing an indication which stress measuring device is most suitable for a particular animal, and with an activation device that activates after animal identification the at least one relevant stress measuring device. Out of all possible parameters that can be measured on an animal the following have proved to be extremely suitable. The parameters are summed up in connection with the device for determining them:

an infrared meter for measuring an infrared image of the animal;

a camera, in particular a video camera, for determining the position of the ears and/or the head and/or the tail of the animal;

a hygrometer for determining the humidity of the fur respectively the nose of the animal;

a movement behaviour meter, such as a video camera, a step counter, for determining the movement behaviour, in particular the movement activity, of the animal;

an eye meter, such as a video camera or iris scanner, for determining the eye characteristics of the animal;

a smell meter or odour meter for determining the breath or body odour of the animal;

a muscular tension measuring device, such as a muscle contraction meter or video camera, for determining the muscular tension of the animal;

a video camera for determining whether the animal has its tongue outside its mouth;

a blood analyser for determining the concentration of blood components, such as oxygen, hormones, blood cells, of the animal;

an excrement analysing device for determining the characteristics of the excrement of the animal;

a heartbeat meter for determining the heartbeat of the animal;

a thermometer for determining the temperature of the animal;

a muscle vibration meter for determining the muscle vibrations of the animal.

The invention also relates to a device for monitoring an animal, in particular a cow, the device comprising a stress measuring device for determining stress of the animal, characterized in that the stress measuring device comprises a device selected from the group consisting of an infrared meter for measuring an infrared image of the

animal, a hygrometer for determining the humidity of the fur respectively the nose of the animal, an iris scanner for determining the eye characteristics of the animal, a smell or odour meter for determining the breath or body odour of the animal, a muscular tension measuring device for determining the muscular tension of the animal, an excrement analysing device for determining the characteristics of the excrement of the animal, a muscle vibration meter for determining the muscle vibrations of the animal. Advantageous embodiments are described in the subclaims.

To be able to monitor the well-being of a dairy cow and also to increase the milk production, in a preferred embodiment of a device according to the invention, the device is disposed in a milking parlour and/or a foremilking parlour and/or in a cleaning box for cleaning certain parts, such as the teats of the animal, and/or in a post-treatment box. There is preferably disposed a milking robot in the milking parlour.

For the purpose of facilitating the data transmission the stress measuring device is provided with a buffer memory for containing a number of measurement data. As a result thereof the measurement data have not to be transmitted or read continuously. For that purpose the stress measuring device is preferably provided with a transmitter for transmitting data. The stress measuring device is preferably provided with a receiver for receiving a transmission order, so that energy can be saved and the stress measuring device can be driven for a long time on e.g. batteries.

Although it is possible to process the data per stress measuring device separately, for obtaining an accurate indication the device is preferably provided with a central unit comprising a computer having a memory for processing measurement data measured by the stress measurement device. As a result thereof it is possible to combine in a simple

manner different parameters for obtaining a stress indication. This central unit is in particular provided with a reading device for reading the stress measuring device.

When the central unit comprises a correspondence table, said correspondence table containing per animal stress related data, such as limit values, historical data and tolerance ranges, there can not only be given an indication of the momentarily measured value of a stress parameter, but there can also be obtained an indication whether the momentarily measured value leads to special action of e.g. the farmer. For that purpose in particular the central unit is provided with a comparing device for comparing the measurement data with the data in the correspondence table and/or for comparing the stress measurement data obtained before, during, and preferably also after milking during a milking run. The computer is preferably loaded with a program for giving, on the basis of the comparison of the comparing device, an indication about the amount of stress of the animal.

After comparison of the momentarily measured values of the parameters with the correspondence table respectively after mutual comparison of the stress measurement data, there can also be given an indication whether the animal runs the risk of showing stress, e.g. by comparing the stress pattern in successive measurements. For that purpose the computer program is preferably suitable for giving a prognosis of the stress behaviour.

The parameters giving an indication of stress varying per animal, it is advantageous when the device is provided with various stress measuring devices, the computer containing an algorithm for attributing a weighing factor to a particular stress measurement data.

For the purpose of displaying the processed data, the central unit is provided with a signal issuing device for issuing a signal after receipt and processing of the stress

measurement data. The signal preferably produces an image on a display screen, printer or the like giving information about the stress behaviour of the animal.

The device comprises an animal identification system known per se. Such an animal identification system provides the possibility of collecting the measurement data per animal, comparing them and the like. The invention also relates to an animal identification system comprising means for connecting the animal identification system with a GPS-system. This makes it possible to determine the position of an animal, e.g. a cow, in a shed. As a result of the fact that the position can be determined, there can be made use of an automatic analysis vehicle that traces an animal and determines the stress parameters on the spot. The invention also relates to such an automatic GPS-controlled analysis vehicle for determining stress parameters. Such a vehicle may also contain the central unit.

The device preferably comprises a stress measuring device, the stress measuring device preferably supplying a signal to an alarm device on the basis of the stress measured.

The invention also relates to a method of milking an animal, in particular a cow, characterized in that the method comprises the step of determining stress of the animal before and during, and preferably also after milking. Advantageous embodiments are described in the subclaims.

The invention will now be explained in further detail with reference to the accompanying figures, in which:

Figure 1 is a side view of a first embodiment according to the invention, and

Figure 2 is a second embodiment of a device according to the invention.

Before going more deeply into a description of the embodiments of the invention, first the basis of the

invention will be described briefly. Stress can manifest itself by various behavioural reactions, possibly in combination with physiological reactions. In particular on the basis of the specific combination of such reactions, a stress reaction can be distinguished from a physical adaptation to a changing environment. In other words, there does not exist one parameter for univocally indicating stress, although one parameter appears to provide a stronger indication of the degree of stress than another parameter. Per animal there appears to be a particular parameter, or a limited number of parameters, which with regard to the determination of stress is/are more important than other parameters. Therefore, combining different parameters, in particular behavioural parameters and physiological parameters, provides an improved monitoring of an animal.

The invention can be applied to all animals, but hereinafter the invention will be explained in a non-limiting way with reference to dairy cows 2, as shown in Figures 1 and 2. When dairy cows 2 are nervous or stressed, in particular before, during and after milking, they appear to behave restlessly, accentuated by frequent movements of the body, stepping or kicking with one of the hind legs. Additionally important physiological systems appear to be activated, as a result of which inter alia the production of hormones, the heart beat rate, plasma concentrations of the blood are influenced. A comparison of the situation before and during, and preferably also after milking, may provide useful information.

The increased production of adrenaline before and during milking is highly undesirable, as adrenaline influences the concentration of oxytocin that stimulates the milk yield.

Behaviour (stepping; kicking; position of head, tail, ears); heart beat; blood samples inter alia for analysis of oxytocin, cortisol, adrenaline, noradrenaline,

percentage of oxygen, content of blood cells and the like, are constantly (i.e. regularly or continuously) measured. In particular these parameters are measured before and during, and preferably also after milking, and milk related data, such as fat content, protein content and the like, are preferably stored. In particular the stress related data together with the milk flow per udder quarter of animals are stored during milking. An animal identification 22 ensures that these data are stored per animal.

Heart beat can for example be measured by means of a band 17 around the leg or the abdomen of the cow 2. Alternatively or additionally a heart beat meter known per se may be disposed on the cow 2 near a place where an artery is located, in this connection the udder, or an ear of the cow can be taken into consideration. A suitable heart monitoring system can for example be obtained with Polar Electro Oy, Helsinki, Finland. Alternatively a heart beat meter can be included in at least one of the teat cups 4.

Blood samples can be taken by suitable devices, comprising a syringe and analysing equipment 15, at places where a cow 2 regularly stays. There may for example be provided in a milking robot 3 (Figure 1) a robot arm carrying a syringe taking automatically a blood sample during milking without the treatment of the cow 2 being hindered thereby. Such a device may also be disposed e.g. in the cubicle 23 with cushion 24 (Figure 2), feeding stations or the like. There may also be provided an automatically controlled vehicle containing such a blood sample device, and possibly other stress measuring devices. Such an automatically controlled vehicle preferably comprises an animal identification system and may inter alia be GPS-controlled. To that end the vehicle comprises a computer with transmitter-receiver, so that the computer is able to receive data from the GPS-system about the position of the cow 2 that wears for that purpose a special transponder 22. Thus the

vehicle can be programmed for measuring a certain number of times per day the stress situation of all cows belonging to a herd.

Blood samples can also be taken by means of a (non-shown) blood sample taking device provided in the cow 2.

In the shed, in particular in the waiting area in front of the milking parlour, and in the milking parlour 1, there is disposed a camera 6, 7, 9, 11, 14 for observing the cows 2. It will be obvious that a plurality of cameras can be used. The video images are analysed by movement recognition programs for the purpose of determining parameters such as stepping; kicking; position of head, tail, ears, back curvature (indication of muscular tension); position of tongue; eye movements. To that end the image per cow 2 is compared with stored historical data regarding the cow 2.

Further the urine and excrement of the cows 2 are analysed (on a less frequent basis) by an excrement analysing device 16. In this connection manual taking of samples can also be taken into consideration.

There may further be provided a hygrometer 8, a step counter 10, a smell meter 12, a muscle contraction meter 13, a thermometer 18 and/or a muscle vibration meter 19.

It is noticed that besides a step counter other ways of determining the number of steps are possible as well. When for example a so-called weighing floor is provided in the milk box, on the basis of the speed variation of the measured values there can be obtained an indication about the number of steps. Quick variation in the weighing values are an indication of a more restless animal rather than almost no variation. Besides, with milking robots making use of a so-called cow follower, the nervousness or stress of a cow can be deduced from the movements the cow follower has to carry out.

All these measurement data are transmitted by the stress measuring devices to or read by a central unit 20 that

is possibly connected with several reading devices disposed at several places in the shed. Said central unit 20 comprises a computer having a memory in which per cow 2 limit values and tolerance ranges in relation to the relevant parameters for stress behaviour are stored. The momentary measured values are kept at least temporarily.

For analysing the stress related data, such as the number of steps, position of the head, binomial and Poisson distributions known per se, as well as logit and log transformations are applied by the computer, for causing the central unit 20 to issue a signal about the stress behaviour of the cow. This signal can give an indication of the stress behaviour on a display screen 21 or a printer. In particular the dispersion of the Poisson distribution is estimated by the Pearson chi-quadratic statistics. Furthermore, associations between different parameters are deduced from Spearman's rank-order correlation coefficient. By means thereof, or by means of comparable other operations, it is possible to deduce per cow 2 those parameters that are more relevant to the determination of stress behaviour than other parameters. Thus there can be attributed a weighing factor to particular parameters. Moreover, it is then possible to distinguish whether a cow 2 is keen on entering the milk box 1 or on the contrary is not so eager to be milked. This can further be deduced from the degree of stress during or after milking. When for example the degree of stress is high before milking, but strongly decreases during milking, it can be deduced therefrom that the cow has a so-called positive stress prior to being milked.

A comparison is possible when previously measured standard values are determined and inputted into the system. Furthermore, these standard values can continuously be updated on the basis of the measurements.

As described, Figure 1 is a side view of a milk box 1 with a cow 2 present therein. The milk box 1 is provided

with a milking robot 3 with teat cups 4 that can be connected automatically to the teats of the cow 2 with the aid of the milking robot 3. Near the front side of the milk box 1 there is further provided a feeding trough 5 to which concentrate can be supplied in metered portions. Other components of the milk box and milking robot are not shown in the drawing for the sake of clearness.

As described, Figure 2 shows a cubicle 23 with a cushion 24 on which a cow 2 is able to lie. In such a cubicle 23 a cow 2 can rest, ruminate and the like. For the sake of simplicity only a few possible components are shown, such as a camera 7, smell meter 12, thermometer 18, and animal identification 22, but it will be obvious that also other stress measuring devices as described above can be used.

The invention also relates to making use of the stress of an animal for the purpose of managing and/or monitoring a herd of animals. To that end the device is further provided with an animal identification system 22 known per se. This animal identification system 22 contains reading devices for reading an animal identification worn by an animal, in particular a cow. As known, data from the animal identification are centrally stored by a central unit 20 provided with a computer having a memory containing several memory files. The central unit 20 centrally controls the functions of the device.

According to the invention the memory is provided per animal of the herd with data in relation to the stress of the animal in the herd. These data can initially be inputted with the aid of data based on experience as known to the farmer. The data in relation to the hierarchic order and the jostling behaviour can additionally automatically be kept and updated by the device.

The functioning of the device according to the invention will be explained in further detail with reference to the entrance to a milking parlour. However, it will be

obvious that the invention is not limited to this example, but can be applied to all automatic animal related treatments that are customary in managing a herd of animals.

When dairy animals wish to make use of the milking robot 3 in the milking parlour 1, they first have to enter a waiting area via one of a number of entrance gates. When it is detected that one of the animals in front of the entrance gates shows such a high stress that milking by the milking robot 3 would be unjustified at that moment, then the relevant entrance gate is blocked. Other, non-stressed animals can use one of the other entrance gates. The detection takes place by a reading unit known per se. During milking the stress can be measured by means of stress measuring devices present in the milking robot.

A dairy animal that has been milked by the milking robot 3 can leave the milking parlour 1 via exit gates. Also in this situation the operation of the exit gates can be controlled partially on the basis of the stress of the animal. Thus it is possible to guide a stressed animal to a calming area via the exit gates.

The gates controlled by the central unit 20 thus provide the possibility of guiding an animal in dependence of the degree of stress. For the determination of the degree of stress one of the above described stress measuring devices can be used. In particular a stress measuring device can supply a signal to an alarm device in dependence of the degree of stress measured. Such an alarm signal may be an audible or visible signal, but may also be a call via a telecommunication network to the farmer or a service department.